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Effect of Sowing Dates on Yield and Yield Components in Wheat Using Stability Analysis

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ABSTRACT

Genotype x environment interaction for grain yield, number of tillers per meter row, number of grains per spike and 1000 grain weight was determined by planting ten wheat varieties in six different sowing dates at Wheat Research Institute, Faisalabad over two consecutive years 2000 - 01 and 2001 - 02 under irrigated conditions. Stability Analyses were computed for grain yield, number of grains per spike, number of tillers per meter row and 1000 grain weight. Stability analyses of variance showed highly significant ($P < 0.005$) differences for environments, genotypes and environment (linear), for all the traits studies except grain yield in which, non-significant result was obtained for genotype. Different genotypes remained stable and adaptive for different traits. For grain yield three varieties Inqilab-91, AS-2002 and V-97112 with bi value near to unity, non-significant ($P < 0.005$) deviation from regression and above average yield were prove to be stable genotypes. As regards number of grains per spike Inqilab-91 and SH-2002 were classified as stable varieties. The varieties Uqab-2000 and Iqbal-2000 for 1000 grain weight and Chenab-2000 and MH-97 for tillers showed stability. The higher grain yield, grains per spike and tillers per meter row were obtained when the crop was seeded on November 10. The 1000 grain weight was higher when crop was planted on October 25. The percentage reduction in grain yield after November 10 planting was calculated as 14.45, 24.26, 36.71 and 48.04% from crop planted on November 25, December 10, December 25 and January 10, respectively.

Key Words: Wheat; Stability; Regression coefficient; Yield; 1000 grain weight

INTRODUCTION

Wheat is a prime food crop in Pakistan. It is grown on a fairly wide range of soil and climatic conditions. Planting time is one of the important factors influencing wheat production. Wheat breeders have recently emphasized the planting of varieties at their optimum times for maximum yield production. For late planting, earliness in flowering and maturity was considered a desirable characteristic. The task of breeder is to screen out genotype planted at different interval to enable selection of those varieties, which are suitable for wider range of planting. Hence a study of genotype x environment interaction can lead to successful evaluation of wheat cultivars for stability in yield performance across environments. The measure of the relative performance of varieties under different environments provides information on stability pattern of these varieties. Statistical methods are available for estimating phenotypic stability as proposed by Eberhart and Russell (1966), Finally and Wilkinson (1963). Ahmad *et al.* (1966) found that linear and non-liner components of genotype X environment interaction were significant, indicating genetic differences among genotype for their response to varying environments. Significant differences among families x years in spring wheat were detected by Yang and Baker (1991). Similarly, significant genotype x environment interactions were also reported by Arian and Siddiqui (1977), Choudhry *et al.* (1978), Bush *et al.* (1976), Mishra *et al*. (1992), Ahmad *et al.* (1996) and Khan *et al.* (2001) found that planting time is the month of November and delayed panting significantly reduce the yield one % for every day after November 10. Iqbal *et al.* (2001) also found yield reduction were 27 and 52% when crop was sown on December 15 and 31, respectively as compared to 1st December sowing. Many research scientists Bush *et al.* (1976), Khan *et al.* (2001) and Nazir *et al.* (1980) found linear reduction in grain yield of wheat by delaying planting.

MATERIALS AND METHODS

Ten wheat genotypes viz., V-97112, SH.2002, V-97052, AS.2002, WD-98613, Chenab-2000, Uqab-2000, Iqbal-2000, Inqilab-91 and MH 97, were evaluated at six different dates of sowing (October 25, November 10, November 25, December 10, December 25 & January 10) for two successive years i.e., 2000 - 01 and 2001 - 02 at Wheat Research Institute, Faisalabad for grain yield, tillers per meter row, number of grains per spike and 1000 grain weight. The experiment was laid out using randomized complete block design three replications. The seed rate was used 100 kg ha^{-1} and fertilizer was applied @ 100 - 75 NP kg ha^{-1} in whole of the experiment. All the experimental plots were agronomically treated alike. The data were recorded for grain yield, tillers per meter row, number of

grains per spike and 1000 grain weight. At maturity, net plot size of 5.40 m^2 was harvested for grain yield. Analysis of variance for each trait was computed as proposed by Steel and Torrie (1980). Thereafter the plant traits showing significant genotype x planting dates were further analyzed for stability analysis using Eberhart and Russell (1966) techniques. Two stability parameters i.e., regression coefficient (bi) and deviations from regression (sd^2) were worked out and tested by using t-test and F-test separately from the pooled analysis.

RESULTS AND DISCUSSION

After computing analysis of variance data regarding all traits showing significant differences were further subjected to stability analysis following Eberhart and Russell (1966). As shown in Table I from pooled data there were highly significant differences for environment, environment (linear) and genotype except grain yield, which was non-significant. For genotype X environment interaction, non-significant ($P > 0.05$) difference, were observed for all the traits except 1000 grain weight, which is highly significant. Genotype X Environment (Linear), were non-significant for grain yield and tillers per meter row and significant for grains per spike and highly significant for 1000 grain weight. The regression coefficient (bi) means the linear response to environmental changes and deviation from regression (Sd^2) measures the consistency/stability of that response. According to Eberhart and Russell (1966), b value around unity and (sd^2) close to zero or minimum is the indication of less response to environmental fluctuation hence more adaptive. A variety with b value higher than 1 is more responsive meaning suitable for favourable environment and b value less than I is suitable for poor environment. Finlay and Wilkison (1963) computed a linear regression of seed yield for variety on mean yield of all varieties for each location. According to that a stable variety is one for which the regression coefficient does not differ from zero and thus stability b defined as the consistency in performance of a variety over varying environments. The regression coefficient bi value of the 10 genotypes ranged from (0.95 to 1.10), (0.69 to 1.27), (0.44 to 1.68) and (0.77 to 1.58) for grain yield, tillers per meter row, number of grains per spike and 1000 grain weight, respectively. This indicated a lot of variation of linear response of varieties to environmental changes.

As regard of grain yield, genotypes as well as genotypes and environment interaction was non-significant, indicating no genetic difference among genotypes for environmental response. The wheat varieties Inqilab-91, AS-2002 and V-97112 with regression value of 1.08, 0.95 and 0.97, respectively non-significant deviation from regression and above the average yield of the trial were wider adaptive over different environment. The lines V-97052 and WD-97613 also have regression coefficient close to unity and variance due to deviation from regression non-significant but their average yield is lower than the average of trial were not wider adaptive. Similar findings reported by Ahmed *et al.* (1996), Norden *et al.* (1986) and Arian and Siddiqui (1977). Considering the yield performance maximum yield (5720 kg ha^{-1}) was obtained from November 10 planting. A reduction in yield was recorded 42 kg $ha^{-1}day^{-1}$ after November 20 planting. Similar results were reported by Khan *et al.* (2001), Chaudhry *et al.* (1995) and Iqbal *et al.* (2001). From the pooled data the wheat varieties Inqilab-91, AS-2002, Uqaib-2000 and V-97112 out yielded the other varieties for grain yield (Table VI).

Table I. Pooled analysis of variance for grain yield and yield components of different wheat genotypes

Variance sources/genotypes	D.F.	Mean squares			
		Grain yield (Kg/ha)	Tillers/M. row	Grain/spike	1000 KW (gm)
Environments	11	11761250**	1340**	110**	215**
Genotypes (G)	9	111303ns	1776**	140**	67**
G x Env.	99	66410ns	100ns	10.82ns	4.95**
Environments(liner)	1	129373800**	14742**	1219**	2374**
G x Env.(liner)	9	53298ns	74ns	22*	15**
Pooled deviations	100	60946	93	8.68	3.47
V-97112	10	25902	68.29	6.538	5.48
SH.2003	10	56299**	107.63	6.0578	1.2614
V-97052	10	30867	97.66	1.1669	0.7216
AS.2003	10	11834**	42.72	21.12	7.745
WD-97613	10	24762	114.90	10.9163	3.6901
CHENAB.2000	10	64945	90	17.19	5.3437
UQAB-2000	10	79341	77.0155	2.7225	3.001
IQBAL.2000	10	106923	109.7952	7.185	2.433
INQ.91	10	19549	41.556	9.8024	1.3062
MH.97	10	82842	81..1939	4.1391	3.7827
POOLED ERROR	357	19445	35.4594	5.86	1.42

Table II. Stability characterization for grain yield of 10 wheat genotype

Genotype	Mean yield Kg/ha	Relative yield to average	Regression coefficient (bi)	Variance due to deviation from regression (sd^2)
V-97112	4559	33	0.97 ± 0.044	6457ns
SH.2003	4510	-16	0.96 ± 0.066	36854*
V-97052	4505	-21	0.97 ± 0.048	11422ns
AS.2003	4602	76	0.95 ± 0.095	-7611ns
WD-97613	4520	-6	1.10 ± 0.043	5317ns
CHENAB.2000	4538	12	1.09 ± 0.070	45500*
UQAB-2000	4609	83	0.91 ± 0.078	59896**
IQBAL.2000	4309	-217	0.97 ± 0.090	87478**
INQ.91	4655	129	1.08 ± 0.038	104ns
MH.97	4457	-69	1.08 ± 0.080	63397**

Table III. Stability characterization for tillers/m row of 10 wheat genotype

Genotype	Tillers per meter row	Relative yield to average	Regression coefficient (bi)	Variance due to deviation from regression (sd^2)
V-97112	101.79	-9.6	0.77 ± 0.215	32.83ns
SH.2003	105.27	-6.12	1.24 ± 0.270	72.17*
V-97052	107.00	-4.39	0.69 ± 0.257	62.20*
AS.2003	103.88	-7.51	1.13 ± 0.170	7.26ns
WD-97613	104.83	-6.56	1.03 ± 2.792	78.54*
CHENAB.2000	126.02	14.63	0.79 ± 0.359	54.54ns
UQAB-2000	111.31	-0.08	1.14 ± 0.228	41.55ns
IQBAL.2000	111.44	0.05	1.18 ± 0.272	74.33*
INQ.91	102.77	-8.62	0.76 ± 0.167	6.09ns
MH.97	139.60	28.21	1.27 ± 0.234	45.73ns

Table IV. Stability characterization for 1000 grain weight of 10 wheat genotype

Genotype	1000 grain weight (gm)	Relative yield to average	Regression coefficient (bi)	Variance due to deviation from regression (sd^2)
V-97112	36.57	0.23	1.25 ± 0.152	4.06*
SH.2003	36.89	0.55	0.77 ± 0.072	-0.16ns
V-97052	36.72	0.38	0.81 ± 0.055	-0.7ns
AS.2003	40.43	4.09	1.58 ± 0.180	6.32**
WD-97613	36.46	0.12	1.05 ± 0.124	2.27*
CHENAB.2000	36.46	0.12	1.11 ± 0.150	3.92*
UQAB-2000	36.41	0.07	0.83 ± 0.112	1.58ns
IQBAL.2000	34.73	-1.61	0.92 ± 0.101	1.01ns
INQ.91	37.82	1.48	0.78 ± 0.074	-0.12ns
MH.97	30.99	-5.35	0.89 ± 0.126	2.36*

Table V. Stability characterization for grain per spike of 10 wheat genotype

Genotype	Grain per spike	Relative yield to average	Regression coefficient (bi)	Variance due to deviation from regression (sd^2)
V-97112	38.36	-2.50	0.44 ± 0.231	0.67ns
SH.2003	42.08	1.22	1.11 ± 0.222	0.19ns
V-97052	39.75	-1.11	1.13 ± 0.097	-4.70ns
AS.2003	38.58	-2.28	0.53 ± 0.416	5.26*
WD-97613	39.71	-1.15	1.14 ± 0.299	5.05ns
CHENAB.2000	35.17	-5.69	0.70 ± 0.375	11.33ns
UQAB-2000	47.88	7.02	1.49 ± 0.149	-3.14ns
IQBAL.2000	43.95	3.09	1.68 ± 0.242	1.32ns
INQ.91	42.03	1.17	1.24 ± 0.283	3.94ns
MH.97	41.17	0.31	0.53 ± 0.184	-1.7ns

Table IV. Grain yield Kg/ha performance of 10 wheat genotype over two years

Genotype	Oct.25	Nov.10	Nov.25	Dec.10	Dec.25	Jan.10	Avg
V-97112	5798	5659	4775	4353	3736	3032	4559
SH.2003	5763	5620	4697	4300	3701	2975	4510
V-97052	5659	5657	4766	4241	3625	3083	4505
AS.2003	5120	5956	5270	4474	3847	2946	4602
WD-97613	5657	5633	4993	4394	3527	2916	4520
CHENAB.2000	5594	5833	5077	4453	3523	2750	4538
UQAB-2000	5918	5390	4837	4478	3685	3348	4609
IQBAL.2000	4893	5776	4928	4171	3306	2777	4309
INQ.91	5837	5959	5067	4318	3797	2951	4655
MH.97	5962	5721	4524	4136	3543	2946	4457
Means	5620	5720	4893	4332	3620	2972	

In case of tillers per meter row (Table III) the varieties MH 97 and Chenab-2000 with regression coefficient value 1.27 and 0.79 and non-significant deviation from regression are seems to be stable for this trait. MH.97 with bi-value more than 1, non-significant deviation and above the average was good for favorable environment and Chenab-2000 with b value lower than 1 seemed to be fit for late planting as compared to MH.97. Considering the over all performance (Table VII) maximum tillers per meter row 120.34 was produced from November 10 planting. While the wheat varieties MH.97 and Chenab-2000 produced 139.60 and 126.02 tillers per meter row, respectively.

As indicated in Table I genotype X environment interaction was significant showing that genotype behaved differently in different sowing dates. The result regarding 1000 grain weight the wheat varieties V-97052, Uqab-2000 and Iqbal-2000 with bi value less than 1 but close to unity with non-significant variance due to deviation from regression are classified as stable varieties (Table IV). Iqbal-2000 although posses b-value close to unity and non-significant deviation from regression but lower yield than the trial average hence not stable one. Considering the 1000 grain weight maximum 1000 grain weight 43.44 gm was produced by November 10 planting. In case of varieties AS.2002 and Inqilab-91 produced the highest 1000 grain weight with a value of 40.43 and 37.82 gm, respectively (Table VIII).

For number of grains per spike (Table V) Iqbal-2000 and Uqab-2000 showed high bi-value, non-significant deviation from regression are fit for favourable environment i.e., early planting only. On the other hand the wheat varieties Inqilab-91 and SH.2002 with bi value above 1, non-significant deviation from regression seemed to be stable varieties. The wheat line V-97052 also possessed all

Table VII. Tillers per meter row of 10 wheat genotype over two years

Genotype	Oct.25	Nov.10	Nov.25	Dec.10	Dec.25	Jan 10	Avg
V-97112	102.13	111.63	106.25	99.50	106.00	85.25	101.79
SH.2003	102.50	111.13	112.88	105.00	106.88	93.25	105.27
V-97052	104.50	102.88	119.75	112.00	108.38	94.50	107.00
AS.2003	92.13	113.13	108.63	103.13	117.00	89.25	103.88
WD-97613	85.88	119.38	101.75	101.38	116.88	103.75	104.83
CHENAB.2000	121.88	132.50	130.75	145.13	127.25	98.63	126.02
UQAB-2000	90.88	127.75	124.88	106.00	116.00	102.38	111.31
IQBAL.2000	92.00	121.25	127.00	96.50	124.50	107.38	111.44
INQ.91	88.50	105.50	107.25	100.38	113.38	101.63	102.77
MH.97	132.38	158.25	145.13	140.38	134.00	127.50	139.60
Means	101.28	120.34	118.43	110.94	117.03	100.35	

Table VIII. 1000 grain weight (gm) of 10 wheat genotype over two years

Genotype	Oct.25	Nov.10	Nov.25	Dec.10	Dec.25	Jan.10	Avg
V-97112	42.47	39.93	38.37	36.27	35.75	26.61	36.57
SH.2003	42.77	37.58	37.96	36.37	33.58	33.08	36.89
V-97052	42.45	37.45	38.66	36.58	32.60	32.59	36.72
AS.2003	52.75	38.63	43.73	40.24	34.75	32.49	40.43
WD-97613	44.63	36.00	37.51	37.97	31.37	31.30	36.46
CHENAB.2000	43.08	41.33	39.74	34.18	30.66	29.75	36.46
UQAB-2000	43.22	36.24	37.91	36.56	33.19	31.38	36.41
IQBAL.2000	42.66	35.04	35.05	33.55	31.88	30.22	34.73
INQ.91	42.65	40.65	39.72	37.24	34.37	32.28	37.82
MH.97	37.75	31.65	34.26	29.88	26.58	25.85	30.99
Means	43.44	37.45	38.29	35.88	32.47	30.55	

Table IX. Grains per spike of 10 wheat genotype over two years

Genotype	Oct.25	Nov.10	Nov.25	Dec.10	Dec.25	Jan.10	Avg
V-97112	39.92	39.06	39.40	39.81	35.04	36.95	38.36
SH.2003	45.79	47.90	41.85	40.75	37.83	38.38	42.08
V-95052	41.11	46.41	39.20	38.84	36.50	36.42	39.75
AS.2003	33.10	41.13	41.74	42.01	36.53	36.96	38.58
WD-97613	43.14	43.70	43.88	38.94	34.45	34.19	39.71
CHENAB.2000	39.14	38.46	33.05	31.40	35.53	33.42	35.17
UQAB-2000	47.63	55.21	50.67	48.65	42.64	42.49	47.88
IQBAL.2000	44.78	55.42	42.96	42.76	37.78	39.99	43.95
INQ.91	40.55	51.16	43.86	41.46	38.24	36.91	42.03
MH.97	45.22	42.34	41.81	40.30	3.55	38.79	41.17
Means	42.04	46.08	41.84	40.49	37.31	37.45	

the parameter fit for stability but its yield is lower than the average of check. Considering the Grains per spike maximum number of grains per spike 46.08 was produced by November 10 planting. However the wheat varieties Uqab-2000, Iqbal-2000, Inqilab-91 and SH.2002 maintained 47.88, 43.95, 42.03 and 42.08 number of grains per spike (Table IX).

The preset study suggest that November 10 is the most optimum time of planting of wheat crop, because the crop sown on November 10 produced the maximum grain yield, number of tillers per meter row and grains per spike. The rate of reduction per day after number 25 planting for grain yield, number of grain per spike, 1000 grain weight and number of tiller per meter row is 42 kg ha^{-1}, 0.097, 0.172 gm and 0.401, respectively. Similar findings were reported by earlier research workers Chaudhry *et al*. (1995), Iqbal *et al.* (2001), Ahmad *et al.* (1996) and Nazir *et al*. (1980). The wheat variety Inqilab-91 is most stable for grain yield, 1000 grain weight and grains per spike, while Chenab-2000 and MH.97 most stable for tillers per meter row.

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